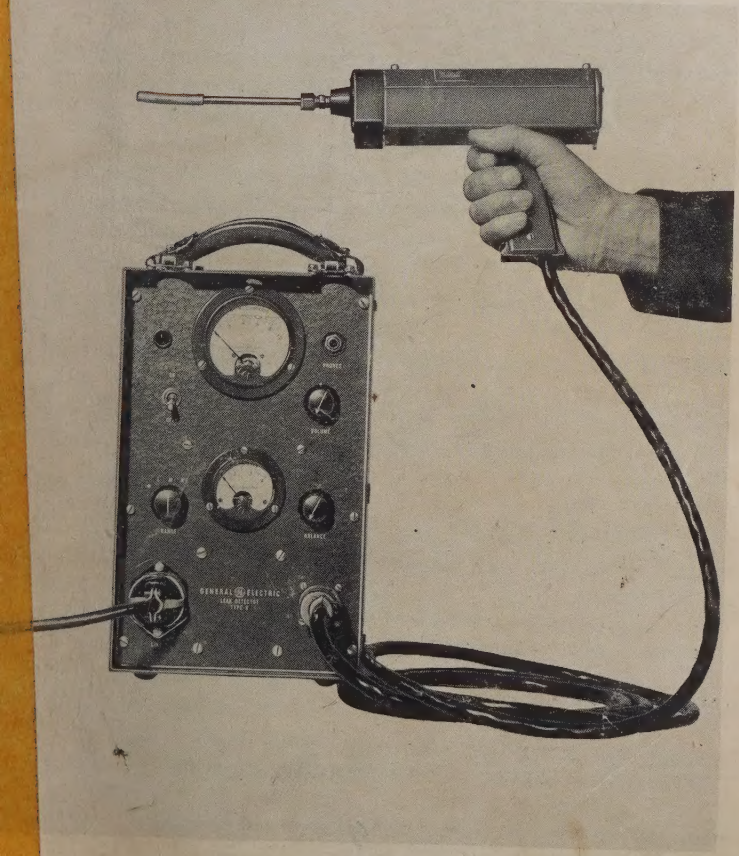
C. Morgan

GEJ-1188B

Type H
LEAK DETECTOR



GENERAL ELECTRIC

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These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

TYPE H LEAK DETECTOR

INTRODUCTION

The Type H leak detector, illustrated on the front cover, is an instrument for detecting the presence of halogen vapors (see section on "Halogen Compounds") and is used for locating small leaks in pressure systems. This instrument can detect a leak so small that in one year only 1/100 of an ounce of Freon will pass through the opening.

This sensitive instrument locates leaks in hermetically sealed refrigerators, home freezers, and air conditioners in which a halogen compound is the refrigerant. It locates leaks also in tanks, boilers, piping and other closed systems into which halogen compounds can be introduced as a tracer.

The detector operates by sucking a sample of air into a vapor-sensitive element of the diode type. The sensitive element and blower are assembled in the hand-held detector unit which is at the end of an electric cable.

The instrument is portable and well suited for assembly-line use, as well as service testing in the field.

HALOGEN COMPOUNDS

The chemical elements chlorine, fluorine, bromine, and iodine are known as the halogen elements, and they are present in a vast number of chemical compounds. The Type H leak detector will show a more or less faint response to almost any change in the air flow or air contamination of the space between the electrodes. However, the most marked response and sensitivity is obtained from the halogen compounds. Normally, these may be introduced into the device either as a vapor or in the form of air-suspended particles. The most common form for the latter is a smoke or a vapor released by a burning substance which contains a halogen compound. Thus, paper, wood, or cloth soaked in sodium chloride, potassium iodide, etc., when burned, will release a smoke to which the device is highly sensitive.

There are a large number of halogen compounds that release vapors and have an appreciable pressure at room temperature conditions. Examples are: carbon tetrachloride, methyl chloride, chloroform, hydrochloric acid, butyl bromide, trichloroethylene, and the several forms of Freon. The leak detector is very sensitive to these compounds. It will respond also to the pure halogens: chlorine, bromine, iodine, and fluorine.

It must be kept in mind that there are a number of halogen compounds in liquid and solid forms that do not have sufficient vapor pressures, under normal conditions, to actuate the detector. A good example of such compounds is the trichlorobenzenes. These are oily liquids (one form is known as Pyranol*) and they are used for dielectric insulation of electric coils. The vapor pressures of such liquids are high enough to be detected only when these liquids are heated sufficiently.

On the other hand, there are a few compounds which are solids at room temperature, but they have vapor pressures which are sufficiently high enough to actuate the detector. One example is paradichlorobenzene. (This material is used frequently to protect fabrics from moths.)

In choosing a halogen compound material, the vapor of which is to be used in leak testing, a number of factors must be considered. Some of these are cost, toxicity, vapor pressure, freedom from fire and explosion hazard, as well as availability. For factory use where a considerable volume is involved, Freon 12 has been found to be very suitable. The following references in connection with Freon and similar compounds may be helpful:

"The Technical Aspects of Freon Refrigerants" by R. J. Thompson, REFRIGERATING ENGINEERING, April, 1937.

"Properties and Characteristics of Refrigerants" by R. J. Thompson, REFRIGERATING ENGINEERING, November, 1942.

"Vapor Pressure of Pure Substances" by Daniel R. Stull, INDUSTRIAL AND ENGINEERING CHEMISTRY, April, 1947; volume 39, p. 517.

*Reg. trade-mark, General Electric Company.

Properties of several Freons are given in folders available from Kinetic Chemicals Inc., 10th and Market Sts., Wilmington, Delaware.

The amount of halogen vapor material required, and the pressure to be used inside of the container to be tested, will vary to a wide degree depending upon the size of the leak to be located and the normal pressure conditions. For some cases, a small amount of Freon 12 blown in from a tank, and then air pressure applied, will be ample. This air pressure may vary from one to two pounds per square inch to 200, but it need not be appreciably higher than that for which the structure is designed or tested.

DESCRIPTION

The Type H leak detector consists of the following:

1—Control unit, Cat. No. 9159506G1 or -G2, with 25-foot power lead, carrying case and strap

1—Detector unit, Cat. No. 9159532G1, with 10-foot cable lead, or

1—Detector unit, Cat. No. 9159532G2, with 35-foot cable lead, or

1—Detector unit, Cat. No. 9345001G1, with 10-foot cable lead.

CONTROL UNITS

Control unit, Cat. No. 9159506G1, is a self-contained portable unit containing the power supply, an amplifier, an indicating instrument, the necessary controls, and a carrying strap.

The power supply furnishes direct current for the detector anode and amplifier. It also furnishes alternating current for the detector filament and rectifier for the blower motor. No part of the circuit is connected to the chassis.

Control unit, Cat. 9159506G2, is like the Cat. No. 9159506G1 unit except that the negative side of the d-c power supply is connected to the chassis.

In operation, when a halogen vapor is introduced into the sensitive element, the impedance between the anode and the cathode decreases. This change of impedance is reflected in the

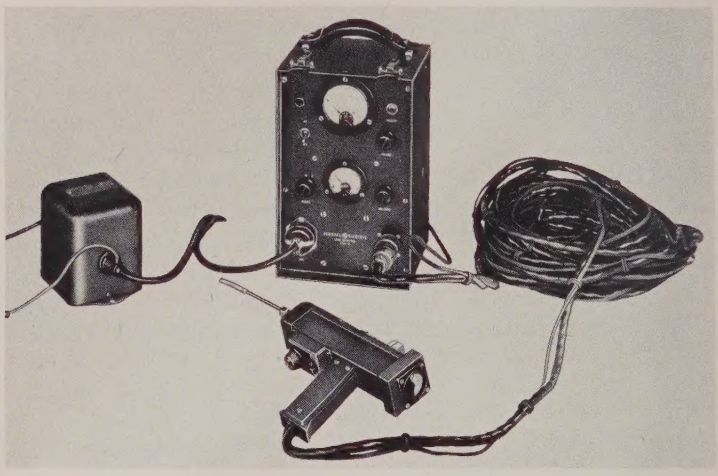


Fig. 1. Type H leak detector. View showing detector unit, Cat. No. 9159532G2 (front), control unit, Cat. No. 9159506G2 (rear), voltage stabilizer (left), and cables (right).

amplifier as a current change and is indicated on the d-c milliammeter. An additional circuit consisting of a gas-tube oscillator (neon lamp) and amplifier (Type 6C5) is furnished so that an audible signal may be obtained, if desired.

At the rear of the control unit is a rheostat with a screw-driver slot which is marked OSCILLATION CONTROL. The purpose of this rheostat is to adjust the point on the milliammeter scale at which it is desired to have the audio signal start.

At the front of the panel is a volume control which controls the amplitude of the audio signal.

DETECTOR UNITS

The detector unit, Cat. No. 9159532G1, is a hand-held device with a pistol grip and a rigid probe with plastic tip. It contains a diode element that is sensitive to halogen in the air, and a blower which circulates the air through the sensitive element. A filter in the plastic tip of the nozzle is included for keeping the sensitive element clean.

Different applications require different probes and, since it is not possible to design a probe which will cover all situations, the detector unit is so constructed that the user can easily make probes for his own particular use. Information for constructing several different probe arrangements is given on page 15.

The ten-foot cable connects the detector unit to the control unit. The 25-foot power cable connects the control unit to the 115-volt, 60-cycle power supply.

Fig. 2. Type H leak detector, showing carrying strap arrangement with control unit, and detector unit

Detector unit, Cat. No. 9159532G2, is a hand-held unit for use with control unit, Cat. No. 9159506G2. It contains the parts found in the standard hand-held type, Cat. No. 9159532G1, with the following added features:

1. An indicating meter at the rear of the detector
2. A neon light at the top
3. A balance control at the bottom
4. A range switch at the bottom, and
5. A 35-foot cable.

This detector was designed for the purpose of enabling the operator to work in inaccessible places at a considerable distance from the control unit and to be able, at the same time, to observe the indicators and operate all the controls.

The plug which is connected to the two-conductor cable should be inserted into the jack at the *rear* of the control unit. This connects the ammeters in the control unit and the detector unit in series.

The indicating meter at the rear is a O-1 d-c milliammeter and gives the same indication as the one in the control unit. The neon light at the top flashes slowly when no halogens are present but flashes at higher frequencies when leaks are detected. The BALANCE control operates in conjunction with the one in the control unit and may be used as a vernier control. The RANGE switch on the detector unit replaces the one on the control unit when the latter is left in the high-sensitivity (H) position and provides the same range of sensitivities.

If this detector is to be used in an area containing hydrogen, it is imperative to follow the special instructions given in the section entitled "The Use of Type H Leak Detector in Areas Containing Hydrogen". See page 30.

The detector unit, Cat. No. 9345001G1, shown in Fig. 3, is a bench-mounted device for use with control unit Cat. No. 9159506G1. It contains a diode element that is sensitive to halogen in the air, and requires a separate means of circulating air through the element and a means of adjusting the rate of flow of air. It might be connected to a vacuum line or vacuum pump with a needle valve to limit the air flow. A Haddaway Mfg. Co.

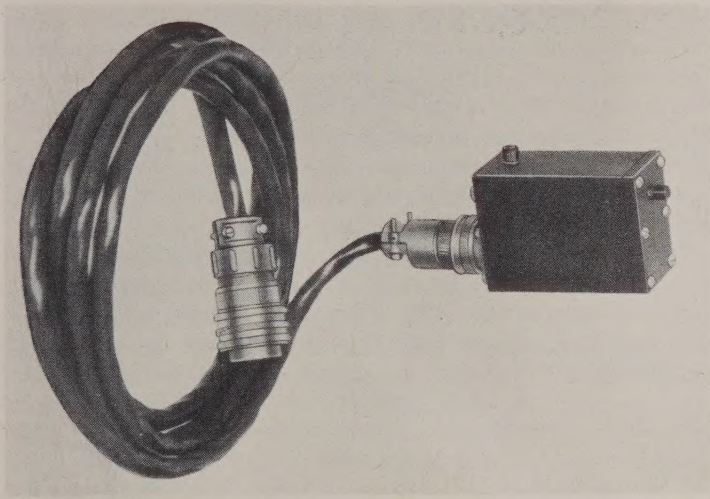


Fig. 3. Detector unit, Cat. No. 9345001G1

White Mist Air Pump can be used if the detector unit is connected to the low-pressure end of the pump.

A suitable tray or cup to hold the pieces to be leak tested can be attached to the air inlet of the detector unit. Provision should always be made for a filter between the tray and detector.

A ten-foot cable connects the detector unit to the control unit.

ADDITIONAL EQUIPMENT

In addition to the foregoing units, an automatic voltage stabilizer is required for satisfactory operation of the instrument from a normal 115-volt, 60-cycle power source. This can be obtained by specifying a G-E Cat. No. 69G861 voltage stabilizer or other stabilizer that is capable of supplying 115-volt, 85-watt output at 0.96 power-factor lag.

It is to be noted that this voltage stabilizer is for use only with the leak detector. If an additional load, such as a loudspeaker amplifier, is placed on this stabilizer, good regulation will not be obtained.

AUXILIARY EQUIPMENT

This instrument is so designed that certain auxiliaries can be conveniently used with it for special applications. Among the most handy of these is the audible signal which, by virtue of its increasing pitch, gives an indication of a leak.

Where the background noise does not mask the indicating signal, a pair of headphones can be plugged into the PHONES jack on the front of the control unit.

Where the background noise is too high, a conventional public-address amplifier and loud-speaker can be used. Its input circuit may be plugged into the PHONES jack in the front of the control unit. Its power lead should be connected at some point ahead of the stabilizing transformer and never in such a way as to place any extra load on the transformer, as poor voltage regulation will result. (Headphones, public-address amplifier and loud-speaker are not supplied by the General Electric Company.)

If it is desired to use an external meter to indicate leaks, an O-1 d-c milliammeter may be connected to a plug which can be plugged into the jack at the *rear* of the control unit. This arrangement places the external meter in series with the one in the control unit and the same indication will be given by both.

If there is need of a visual or audible alarm, an electronic relay, CR7511-B112G1, can be plugged into the jack at the *rear* of the control unit. The power lead should be connected to the power source at a point ahead of the voltage stabilizer to avoid placing an extra load on it. A 120-volt incandescent lamp rated at 60 watts or less can be connected to the output receptacle on the relay. Lamps with higher currents should not be used because they will overload the contacts of the relay.

The contacts are rated not to exceed the following:

Inrush current, five amperes; steady current, two amperes; interrupted current, one ampere.

This relay can be used also to control the operation of a wide variety of devices if an intermediate relay is used in conjunction with it. The coil of the intermediate relay should be rated at about 115 volts, a-c, and should not overload the contacts of the electronic relay. The contacts of the intermediate relay should be rated high enough to accommodate the load to be operated.

Relay CR2790-E100A2 has been found very useful for this application.

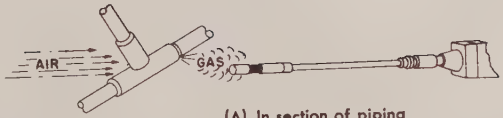
OPERATION

The detector unit with its cable, the carrying strap, the power cable, and the instruction book are packed in the back of the control unit case. Remove them carefully, and inspect for any damage that may have occurred during transit. If the equipment appears to be in good mechanical condition, it can be connected to any commercial 115-volt, 60-cycle power supply. This voltage must be regulated to within plus or minus one volt and generally requires an automatic voltage stabilizer, as previously described.

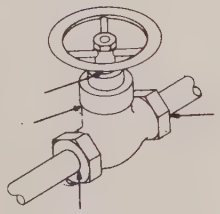
Before turning on the power, remove the plug from the detector nosepiece. Attach the probe after removing the masking tape from both ends. Make sure that the probe does not contain any loose dust or fragments of packing material. Blow it out with compressed air or clean it mechanically, if necessary. Connect the clip at the end of the power lead to a good ground.

Close the OFF-ON power switch and allow the unit to run for at least 30 minutes. At the end of this time, note the sensitive-element current as indicated on the a-c ammeter in the center of the panel. The sensitive-element current should correspond to within approximately one division on the instrument scale of the current marked on the tag attached to the control unit. If this is not so, pry out the small plug on the right-hand side of the control unit case, insert a screw driver in the rheostat slot, and adjust the current to the value marked on the tag. For final adjustment of the current, see the section devoted to "ADJUSTMENT OF SENSITIVITY", page 21. The current marked on the base of the element is only approximate. After the instrument has run for 30 minutes or more, proceed as follows:

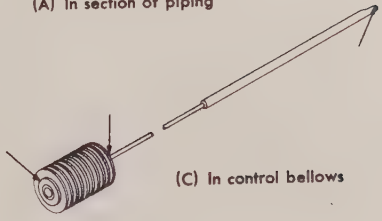
1. In a clean, quiet, draft-free room, free from halogen vapors, observe the reading of the d-c milliammeter, mounted near the top of the panel. Under "no-vapor" conditions, this instrument should read above 0.1 and below 0.2 on the instrument scale. If this is not the case, turn the knob marked BALANCE until this condition is obtained. The instrument is now ready for a trial measurement.



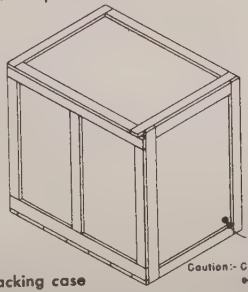
(A) In section of piping



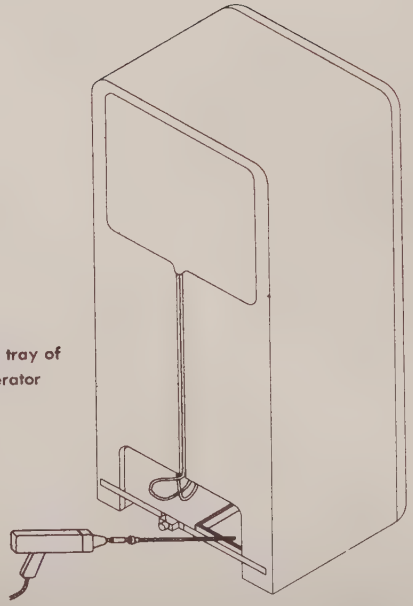
(B) For hand-operated valve



(C) In control bellows


Small hole to be made to permit entrance of probe.
Caution:- Care must be taken not to damage equipment inside of packing case.

(D) In packing case



(E) In drip tray of refrigerator

Fig. 4. Suggested searching procedures

2. Take a small bottle of carbon tetrachloride or similar material, uncork it, and then tightly replace the cork. Place the bottle on the table and slowly approach the bottle with the probe of the detector head. The RANGE selector should be set at the L (low) position; an appreciable deflection of the pointer should result. Then, repeat the test with the knob set in the M (medium) and H (high) positions, respectively. The indicator will be more sensitive in the M position than in the L position. Avoid overexposing the probe to high concentrations of vapor as an appreciable amount of time will be required for the instrument to recover.

3. Repeat the test outlined in Step 2 using the smoke from a lighted cigarette to actuate the instrument. This will help you become familiar with its operation and its response under various situations.

LEAKS AND HOW TO FIND THEM

As previously explained, this instrument is applicable to systems which are filled with those classes of halogens which have high vapor pressures. Most of the vapors which were mentioned are heavier than air, and it is important to take this factor into consideration when searching for a leak.

Until some practice has been acquired in the use of the instrument, it will be found profitable to work methodically and slowly in order to know and determine the best way in which to operate. Work in a clean and quiet room, *FREE FROM HALOGEN VAPORS*.

For example, in looking for a leak in a section of piping, take careful note of any possible drafts in the room and be sure to work on the "lee" side of the draft. Move the probe slowly along the pipe and pay particular attention to joints. See Fig. 4 for suggested searching procedures.

If the device to be tested is small, it will be found convenient to place it in a tight container which has been previously "sniffed" to be sure that no contamination existed. After the device has remained in the container for a few moments, insert the probe into the bottom of the container.

If the apparatus has a drip tray, begin by sniffing the drip tray. It is quite possible that some of the heavy vapor has collected in the tray, and you can determine at a glance if further checks are necessary.

Apparatus which is packed in a paper-board box or wrapped in paper in an open-slot box should be prepared for leak detection by making a small opening in the paper with a sharp-pointed tool. The probe should be inserted carefully through the opening. Do not use the probe as a means of making the opening because particles of lint and dust will eventually be picked up and will find their way into the sensitive element of the detector unit.

CONTAMINATION

It is important to remember that the Type H leak detector is a *comparative instrument and is not intended to measure the quantity of halogen vapor present.* Actually, it compares the degree of contamination which is normally present in the air to that which is present at a leak. This is done by balancing the circuit when the detector is sniffing air and observing a change of current when the amount of halogen increases. It is apparent, then, that the air in the testing area should be as free of halogens as possible if a maximum of sensitivity is expected.

Instability of the indication can very often be traced to contamination of the air, particularly if the testing area is subject to drafts. However, it is possible that an area can be very highly contaminated, but the degree of contamination may be so constant that no change of indication occurs.

Subjecting the sensitive element to most halogens reduces its sensitivity. Comparatively small concentrations over a long period of time will cause the sensitivity to decrease gradually, while large concentrations will produce the same effect quickly. It is possible to have contamination to such a high degree as to make an element practically useless in only a few hours.

ELIMINATION OF CONTAMINATION

It is probably impossible to completely eliminate halogen vapors from any area, but it is usually possible to reduce the concentration to a point where very good results can be obtained.

The first logical step in eliminating contamination is to eliminate the cause, if it can be determined. If this is not feasible, the testing area can sometimes be moved to a different location. If neither of these solutions seems practical, either the entire area can be supplied with halogen-free air or a testing booth can be constructed with clean air forced in under slight pressure by a fan in a duct. The pressure should be high enough to insure a constant flow of air out of the booth, but not high enough to create drafts. A baffle plate in the ceiling is helpful in this respect.

Air taken from a source above the roof of a factory building is usually better than that taken from a source near the ground. Air which contains smoke or paint fumes or similar substances should be avoided.

Whatever means are taken to do so, it is imperative to provide reasonably halogen-free air to the testing area.

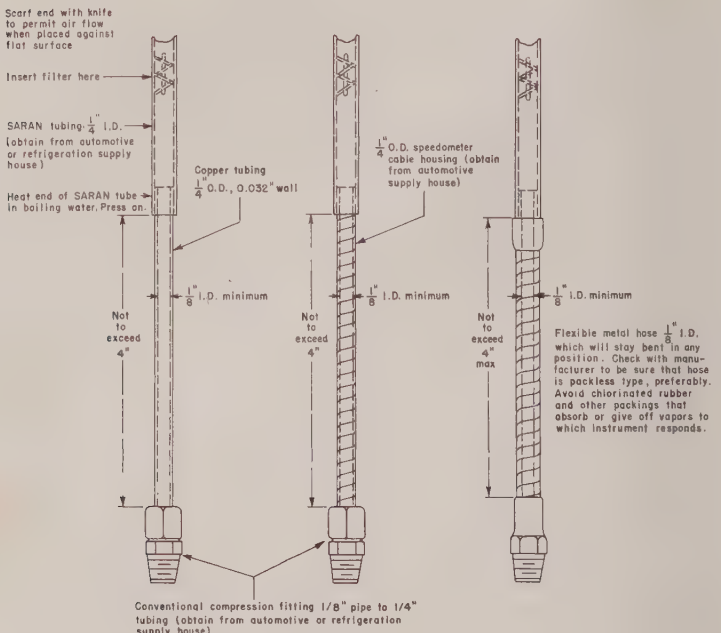
PROBES AND THEIR DESIGNS

It is not possible to design a probe which can be used for all of the applications for which the Type H leak detector is intended. However, the detector unit is so constructed that the user can easily make probes for his own particular use.

Figure 5 shows a number of different arrangements for probe construction. The user can very readily construct a probe from any one of the suggested designs. It should be noted that certain limiting dimensions are shown to which the constructor must conform, if satisfactory results are to be obtained. When probes of the suggested designs are used, the response time will be satisfactory when the detector unit is used for sniffing carbon tetrachloride at room temperature. Probes longer than those shown or which have a larger cross-sectional area than that specified will increase the response time and, also, the recovery time.

ALWAYS BE SURE THAT A FILTER IS INCLUDED IN THE PROBE END OF ANY PROBE DESIGN THAT IS USED. This may be similar to the filter used in the probe supplied with the equipment. It can be made from a short length of Saran tubing and the tiny brush elements inserted.

If a material other than metal is used for the probe, be sure that it does not have the characteristic of absorbing the gas which


Scarf end with knife to permit air flow when placed against flat surface
Insert filter here
SARAN tubing-1/4" I.D.
(obtain from automotive or refrigeration supply house)
Heat end of SARAN tube in boiling water. Press on.
Copper tubing 1/4" O.D., 0.032" wall
1/4" O.D. speedometer cable housing (obtain from automotive supply house)
1/8" I.D. minimum
1/8" I.D. minimum
1/8" I.D. minimum
Not to exceed 4"
Not to exceed 4"
Not to exceed 4" max
Flexible metal hose 1/8" I.D. which will stay bent in any position. Check with manufacturer to be sure that hose is packless type, preferably. Avoid chlorinated rubber and other packings that absorb or give off vapors to which instrument responds.
Conventional compression fitting 1/8" pipe to 1/4" tubing (obtain from automotive or refrigeration supply house)

NOTES

An extension probe is often useful. The information given here will aid the user in constructing probes to fit his own applications.

1. If the limiting dimensions shown above are not exceeded, the response time of the detector unit will not exceed two seconds. A probe may have a larger inside diameter and be longer, but best results are obtained with the shortest lengths.

2. Note that space for a filter is always allowed. Use a filter and keep it clean at all times. The filter can be cleaned of dust by brushing out particles and then passing it through a flame to remove residual dust. If the filter becomes contaminated with oil, throw it away, or degrease it and bake to remove all traces of the degreasing agent. Order replacement filters, in lots of six, from the General Electric Company, and give catalog number of detector unit in which they are used.

3. In making probes, be sure that metal parts are clean and free from oil. If necessary, use degreasing procedure described in Step 2.

4. If only a short section of metal tubing is used, be sure that the plastic tip is not heated sufficiently so that vapors may be given off and a false reading obtained.

5. When the probe is removed, close the nosepiece with a clean ⅛-in. pipe plug or with the cap supplied so that dirt and dust will not enter the sensitive element.

Fig. 5. Probe construction details

is to be detected. This could lead to considerable difficulties. Rubber tubing is particularly bad in this respect.

THINGS TO KEEP IN MIND

This section has been made brief so you will be sure to remember it.

1. Electric circuits. The electric circuits in this instrument contain voltages which may be as high as 300 volts. To keep the detector unit at the potential of the case, an external shield has been placed around the cable. To protect the operator, the case has been connected to one prong in the three-prong plug and a test clip has been provided for grounding the control unit. MAKE USE OF THIS GROUND CLIP.

2. The detector head contains a filament which is heated to a temperature sufficiently high to ignite certain explosive gas mixtures, if they should come in contact with it. Screens are not provided to prevent the propagation of flame.

3. Don't introduce carbon tetrachloride or similar vapors into containers which are to be used later for vacuum systems, unless you are thoroughly familiar with high vacuum techniques.

4. This instrument is made to sniff halogen vapors and not paint fumes or sulphonated oil. Some of the latter can be decomposed on the surface of the sensitive element.

MAINTENANCE

CONTROL UNIT

The control unit is subject to about the same maintenance procedure as the conventional radio set. If the user is unable to service this unit, it can be repaired by any qualified radio service shop. A schematic wiring diagram, Fig. 6, will aid in making any necessary repairs.

In addition to the elementary wiring diagram for the control unit, similar schematic diagrams for the detector units are shown in Fig. 7 and 8. A connection diagram for detector unit, Cat. No. 9159532G1, is shown in Fig. 9.

If an electronic tube fails, it can be easily replaced in the chassis by unscrewing the four screws which are located near the

corners of the front panel. The chassis can then be pulled forward to permit inspection and such testing as may be necessary.

Before looking for the source of any troubles, it is recommended that the line voltage be checked to make sure it is within the required limits (approximately 115 volts, regulated to plus or minus one volt) and that the fuse, mounted on the rear of the control unit chassis, is not burned out.

DETECTOR UNIT

To get the best results with a leak detector, a reasonable amount of care will be necessary. The sensitivity, response time, and recovery time should be checked periodically. A reference leak should be provided for this purpose.

Care should be taken not to drop the detector unit, as this may damage the element or crack the nose cap. Try to avoid picking up dirt or moisture when searching for leaks, and subject it to large doses of halogens as little as possible. The filter in the Saran tip should be kept clean at all times.

It may be found necessary, if the detector has been in use for some time, to remove and clean the sensitive element or to replace it. Since it operates at a high temperature it has a limited life. It is easily reached by removing the screws in the nose cap of the detector unit and unclamping the connections and the tube. The center lead must be unsoldered. The element should be removed carefully to avoid damaging the mica support at the top.

CLEANING THE SENSITIVE ELEMENT

It is necessary to disassemble the element to clean it. The inner cylinder can be removed after the two nuts which clamp the outer leads are removed. Care should be taken not to interchange inner cylinders since they will not fit properly if this is done.

The inner cylinder can be polished by gently rubbing it with a piece of very fine emery cloth. The outer cylinder can be polished by wrapping a piece of emery cloth around a rod and inserting it in the cylinder. Care should be taken not to bend any of the parts.

When reassembling the element, be sure that the fork at the top of the outer cylinder is properly inserted into the two holes in the top of the ceramic. If this is not done, the ceramic may become broken. Before the two nuts at the base are tightened, the inner cylinder should be centered as closely as possible in the outer cylinder.

When inserting a new or repaired sensitive element, slide it very carefully into place taking great care not to bend the mica support at the top. Next, note the approximate element current which is marked on the base and then clamp the element in place. This marked element current also includes the small amount of current taken by the blower unit. Make the heater current setting by reading the ammeter.

It will be observed that one of the sensitive-element leads is connected to a small wire situated on the terminal block. (This is the lead which connects to the nickel-plated terminal in the handle of the detector unit; the other leads are clamped under screws on the sensitive-element terminal block.) When making a connection to this wire, be very careful to make sure that no dirt gets on the tiny glass insulator. *Use resin-core solder only*. This precaution is necessary because the insulation resistance of this circuit must be maintained at a very high value for satisfactory operation.

Before replacing the front cap, make sure that the asbestos gasket is in good condition, free from breaks, and that it seats evenly. It is essential that this gasket be tight and free from leaks; otherwise an appreciable decrease in sensitivity and increase in response time will result.

After replacing the sensitive element, run the unit for about one-half hour to allow it to warm up thoroughly before checking its operation.

SENSITIVITY

To obtain maximum results with a Type H leak detector, three factors are involved. First, the testing area must be reasonably free of contamination. (See section devoted to "Contamination", page 14.) Secondly, the sensitivity should be high enough to easily locate leaks which are to be rejected but not necessarily

high enough to give a large indication on leaks which are passable. Thirdly, the rate of air flow should be high enough to insure a quick response and quick recovery, but not high enough to reduce the sensitivity below the desired level.

REFERENCE LEAKS

The detector can be used for such a wide variety of applications that it is not practical to specify any desired sensitivity. However, a reference leak can be constructed, whose magnitude will be of the order of leaks to be detected.

A fairly stable leak can be made by providing a rolled capillary outlet on a bomb of Freon. The rolling process can be repeated until the leak is of about the same magnitude as those to be detected.

Paradichlorobenzene crystals can also be used to construct a reference device. The crystals should be placed in a bottle which has a wide screw-top. A piece of $\frac{1}{8}$ in. copper tubing should be mounted with one end inside the bottle and the other projecting through the cover into the center of a piece of $\frac{3}{8}$ in. copper tubing about two inches long and at right angles to it. A vent should be drilled in the cover. If the probe of a detector unit is inserted in the larger tubing, vapor will be drawn from inside the bottle and mixed with air flowing through the tubing. The size of the tip of the $\frac{1}{8}$ in. tubing will determine the amount of vapor withdrawn. This device is quite sensitive to temperature changes.

A third method of determining sensitivity uses hexachlorobenzene-tec crystals. They are placed in the bottom of a flask with a narrow neck which is immersed in a tank of water with only the neck protruding. The temperature of the water is held at 73 C. At this temperature the vapor pressure of hexachlorobenzene is about 90 microns. The probe of the unit to be checked is inserted into the flask after balancing in halogen-free air. The Saran tip containing the filter should be removed before this test is made. Other vapor pressures can be obtained by using other temperatures.

Of the three methods of measuring sensitivity, the latter seems to be the most reliable. However, whichever method is used, it is imperative that the halogen content of the air be at a minimum.

ADJUSTMENT OF SENSITIVITY

Adjustment of the sensitivity is accomplished by changing the heater current. This adjustment is quite critical because the sensitivity increases very rapidly with a small increase in temperature.

The sensitivity can be adjusted to the highest practical value by the following means. First, allow the detector to warm up for at least one half hour. Then pry out the plug in the right side of the control unit case. Inside will be seen the shaft of a rheostat with a screw-driver slot. Adjust the current to a value about two-tenths of an ampere below that specified for the sensitive element, reading the a-c ammeter in the control unit. After this adjustment and any subsequent adjustments, allow the unit to run for a few minutes to stabilize the temperature. If the indication on the milliammeter remains steady when balanced to 0.1 or 0.2 on the scale, increase the heater current by about one-tenth ampere and allow the temperature to become stable. Repeat this process until a heater current is reached at which the indication of the milliammeter is no longer stable. This heater current will be slightly too high and it should be reduced to the highest value at which stability occurs.

It should be remembered that a unit which is stable in halogen-free air can be very unstable in a contaminated area. (See section entitled "Contamination", page 14.)

If a major change of heater current is made, the air flow should be checked. Increasing the current increases the voltage applied to the blower motor and consequently increases the air flow. Conversely, reducing the heater current reduces the air flow.

Many applications of the leak detector do not require its use at maximum sensitivity. In such cases it is advisable to operate the detector at the lowest current which will produce the desired sensitivity. This will prolong the life of the element.

As mentioned before, subjecting the sensitive element to halogens will cause a decrease in sensitivity. Consequently it may be found necessary from time to time, during its useful life, to increase its heater current slightly.

It may happen that a new element, which is operating at its

maximum sensitivity in a contaminated atmosphere, will produce a small change of deflection when the detector unit is rotated from a horizontal to a vertical position. In such cases it may be found necessary, if this effect is great enough to be objectionable, to either reduce the heater current slightly or to operate on a less sensitive range until the sensitivity of the element has become slightly lower.

AIR FLOW

The rate of air flow through the sensitive element is an important factor in its operation. If the flow is too high, the small amount of halogen vapor escaping from a leak will be mixed with too much air, reducing the concentration as it passes through the element. On the other hand, if the air flow is too low, the time required for the vapor to travel from the tip of the probe to the element will be too long, and also the time required to clear the detector of vapor after detecting a leak will be too long.

A linear speed of 55 to 65 feet per minute is a satisfactory value for air flow. This is the equivalent of about 0.9 cubic feet per hour.

In the nose cap under the screen there may be a restriction. It is a fiber washer with a small aperture. At the factory, the hole in the restriction is enlarged until the flow has increased to the proper amount. When measuring the flow, be sure that the screen is in place and that the gasket in the nose cap is in good condition, and the nose cap is properly seated.

A convenient instrument for measuring flow is an Alnor Velometer, Jr., Type 8100, manufactured by Illinois Testing Laboratories, Inc. A rubber insulator from a test clip is a convenient means of connecting the velometer to the probe. A special calibration (55-65 ft per min.) should be marked on the scale if this instrument is used to measure air flow in a detector unit.

If a major change of air flow is made, it may be found necessary to change the heater current slightly because the cooling of the element depends to a large extent on the amount of air passing through it.

The following data typifies the operation when the heater current and flow are not properly adjusted.

Heater Current Adjusted Too Low

1. Sensitivity—poor.
2. Response time—poor.
3. Recovery time—good.
4. Stability—good.

Current Adjusted Too High

1. Sensitivity—good.
2. Response time—good.
3. Recovery time—poor.
4. Stability—poor.

Air Flow Adjusted Too Low

1. Sensitivity—good.
2. Response time—poor.
3. Recovery time—poor.
4. Stability—poor.

Air Flow Adjusted Too High

1. Sensitivity—poor.
2. Response time—good.
3. Recovery time—good.
4. Stability—good.

BLOWER UNIT

The blower unit consists of a small d-c motor and impeller. It is easily accessible when the shroud is removed from the detector unit. The later design detector units contain a round motor rated at ten volts, d-c. The speed should be 5500 rpm, plus or minus 15 percent, at rated voltage. Earlier designs contained a square motor whose speed is considerably higher.

If faulty operation of the motor is suspected, first check the motor voltage. The d-c voltage at the motor should be approximately two volts lower than the a-c voltage applied to the rectifier. If the difference is greater than this, the rectifier may be at fault.

Short brushes, faulty bearings, or an open armature will cause the motor to run slow, with rated voltage applied. If the brushes or bearings are faulty, they may be replaced. If the armature is open, the motor must be replaced.

When blower units are reconnected in the detector unit, the direction of rotation should be noted. The fan should rotate clockwise as observed from the driven end. If the rotation is counterclockwise, reverse the leads to the motor.

CABLE REPAIRS

In severe industrial use, the cable gets considerable flexing and strain. If it fails, it will usually fail near the detector unit. The cable may be cut at the point of failure and reconnected to the detector unit in the same manner as the original connectious were made. Be sure that the strain relief clamp is securely tightened.

FAILURES, SYMPTOMS, AND CORRECTIONS

Some of the possible types of failure and their symptoms are listed below.

1. Open heater: No sensitivity, no a-c current, motor runs too fast. Replace element.

2. Short circuit in element due to mechanical failure: Milliammeter off scale, balance control won't function. Disassemble element and repair, or replace.

3. Short circuit in element due to dirt: Same symptoms. Disassemble element and clean it.

4. Connector between heater and inner cylinder open: No sensitivity. Repair connector or replace element.

5. Black lead in cable open: No sensitivity. Repair cable.

6. Short circuit from black lead to inner shield: Milliammeter off scale, balance control won't function. Repair cable.

7. Short circuit from inner shield to outer shield: Erratic indication. Repair cable (does not apply to Cat. No. 9159506G2 control units).

8. Dirty filter: Erratic indication when probe is tapped. Replace or clean filter.

9. Cracked cap or poor gasket: Low sensitivity, long response and recovery time. Replace cap or gasket.

10. Blue lead to element open: No sensitivity. Repair connections.

VOLTAGE TABLE FOR CONTROL UNIT CHASSIS

(Refer to Fig. 6)

Note 1: The voltages listed below should be obtained when the control unit chassis is plugged into a 115-volt automatic stabilizer.

Note 2: The a-c voltages listed were measured with a 1000-ohm-per-volt instrument.

Note 3: The d-c voltages listed were measured with a 20,000-ohm-per-volt instrument.

Note 4: It should be remembered that voltages measured across resistors may vary as much as ± ten percent because of resistor tolerances.

A-C VOLTAGES

For the Power Transformer (T1):

From Terminals	Voltage	Remarks
1 to 2	115	Measured on 250-volt scale.
3 to 4	280	Measured on 1000-volt scale.
4 to 5	280	Measured on 1000-volt scale.
6 to 7	6.6	Measured on 10-volt scale.
8 to 9	6.6	Measured on 10-volt scale.
10 to 11	17.6	Measured on 50-volt scale.

Tube Socket of Type 6X5 Tube:

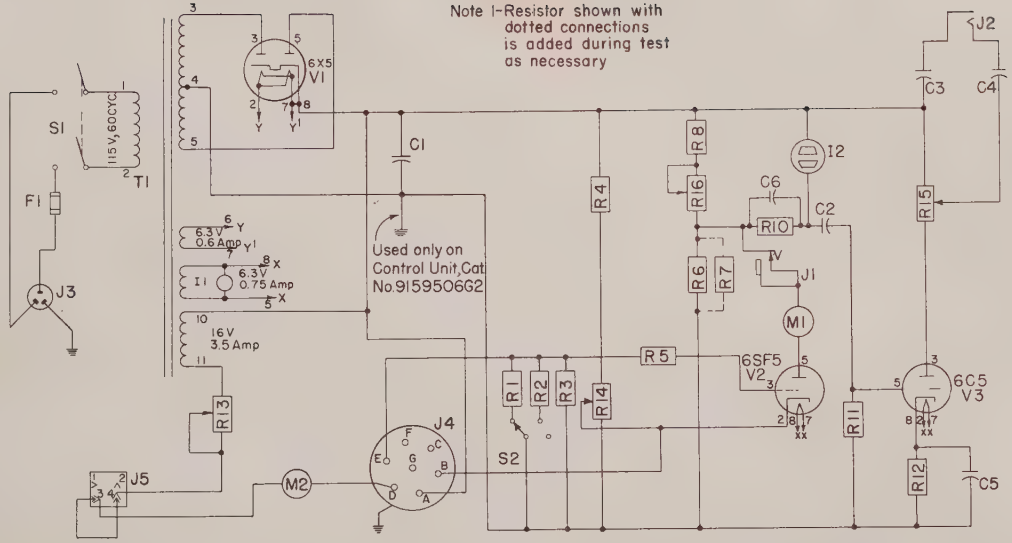
From Pins	Voltage	Remarks
2 to 7	6.6	Measured on 10-volt scale.

Tube Socket of Type 6SF5 Tube:

From Pins	Voltage	Remarks
7 to 8	6.6	Measured on 10-volt scale.

Tube Socket of Type 6C5 Tube:

From Pins	Voltage	Remarks
2 to 7	6.6	Measured on 10-volt scale.



C1—4 mu f, 330-v, a-c
C2—.0001 mu f, 500-v, d-c
C3, C4—.005 mu f, 300-v, d-c
C5—25 mu f, 50-v, d-c
C6—.000025 mu f, 500-v, d-c
R1—100,000 ohms, 1 watt

R2, R5—510,000 ohms, 1 watt
R3—1 megohm, 1 watt
R4—50,000 ohms, 10 watts
R6—240,000 ohms, 1 watt
R7—750,000 ohms to 2 megohms (see Note 1)
R8—47,000 ohms, 1 watt

R10—5.1 megohms, 1 watt
R11—510,000 ohms, 1 watt
R12—1500 ohms, 1 watt
R13—2-ohm, 50-watt potentiometer
R14—5,000 ohm, 2-watt potentiometer
R15—10,000 ohm, 4-watt potentiometer
R16—50,000 ohm, ½-watt potentiometer

Fig. 6. Control unit, Cat. No. 9159506G1 or -G2, elementary wiring diagram

A-C VOLTAGES (CONT'D)

Amphenol Socket (J4):

From Pins	Voltage	Remarks
A to D	17.6	Measured on 50-volt scale. (Cable disconnected.)

D-C VOLTAGES

Test Points	Voltage	Remarks
Across C1	306	Measured on 1000-volt scale.
Pin 5 of Type 6SF5 tube socket to pin 8 of Type 6X5 tube socket	91	At 1-milliampere plate current. Oscillation control set at minimum resistance. Measured on 250-volt scale.
Pin 5 of Type 6SF5 tube socket to pin 8 ot Type 6X5 tube socket	150	At 1-milliampere plate current. Oscillation control set at maximum resistance. Measured on 250-volt scale.
Pin 5 of Type 6SF5 tube socket to brush on switch S2	245	At O-milliampere plate current. Measured on 250-volt scale.
Pin 5 of Type 6SF5 tube socket to brush on switch S2	190	At 1-milliampere plate current. Measured on 250-volt scale.
Pin 2 of Type 6SF5 tube socket to brush on switch S2	29.5	With BALANCE knob in extreme counterclockwise position. Measured on 50-volt scale.
Pin 2 of Type 6SF5 tube socket to brush on switch S2	0	With BALANCE knob in extreme clockwise position.
Pin 3 of Type 6SF5 tube socket to brush on switch S2	0	This should always be zero volts with the cable disconnected from the Amphenol socket.
Pin 3 of Type 6C5 tube socket to brush on switch S2	252	Measured on 1000-volt scale.
Pin 8 of Type 6C5 tube socket to brush on switch S2	8.2	Measured on 10-volt scale.

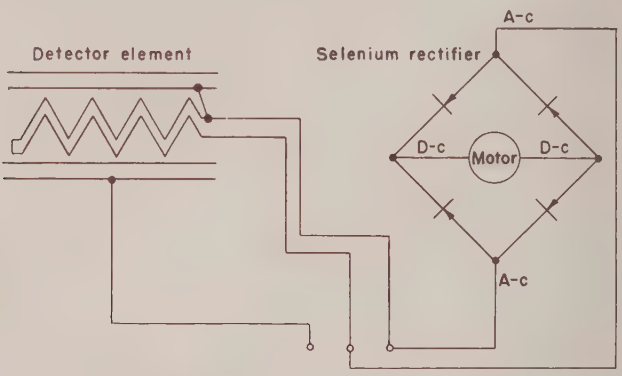


Fig. 7. Detector unit, Cat. No. 9159532G1, elementary wiring diagram

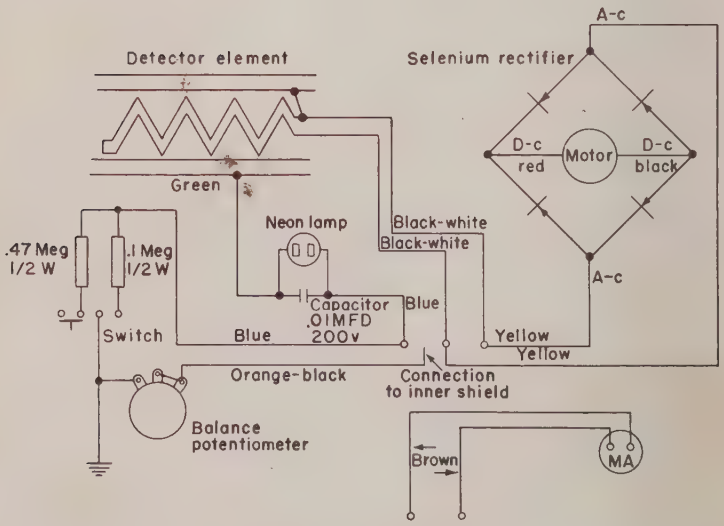


Fig. 8. Detector unit, Cat. No. 9159532G2, elementary wiring diagram

D-C VOLTAGES (CONT'D)

Test Points	Voltage	Remarks
Pin 5 of Type 6C5 tube socket to brush on switch S2	0	
Pins A to B at Amphenol socket (J4)	306	With BALANCE knob in extreme clockwise position. Measured on 1000-volt scale.

RENEWAL PARTS

Complete information on renewal parts for the Type H leak detector is listed in *Renewal Parts Bulletin GEG-6146*, a copy of which is included with the equipment. Additional copies can be obtained by writing to the Distribution Section, Advertising and Sales Promotion Divisions, General Electric Company, Schenectady, N. Y.

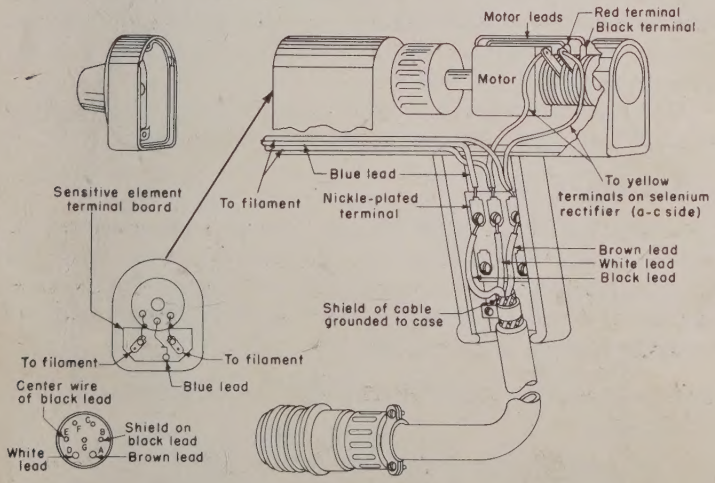


Fig. 9. Detector unit, Cat. No. 9159532G1, connection diagram.

SPECIAL INSTRUCTIONS FOR USE OF TYPE H LEAK DETECTOR IN AREAS CONTAINING HYDROGEN

These instructions are specifically for finding leaks in generator hydrogen systems, but the methods outlined are applicable to other systems.

RESPONSIBILITY OF PURCHASER

It is understood that in consideration of the sale of this instrument by the General Electric Company, the purchaser agrees to release and indemnify the General Electric Company from any claims, arising from the use of the leak detector, which may be asserted by the purchaser or by any other person. The General Electric Company does not assume any responsibility in the event of an accident which might be incurred by the use of this equipment.

The reason for the above statement is that the device was not designed for an application of this nature. However, the Type H leak detector is used successfully by General Electric turbine engineers in determining leaks of hydrogen from hydrogen-cooled generators.

All hazards and safety precautions known and discovered by G-E personnel are set forth in these special instructions.

LABORATORY TESTS

Some tests on the Type H leak detector were made in our Research Laboratory. These tests indicate that for at least one leak detector, hydrogen cannot be ignited until the concentration is about 20 percent. However, it is advisable to consider that any explosive mixture may be ignited.

THE TYPE H LEAK DETECTOR IS NOT A DETECTOR OF HYDROGEN

It will respond almost full scale on the high-sensitivity scale to about ten-percent hydrogen in air and full scale on the low-sensitivity scale to about 20-percent hydrogen in air. This is a small response as compared to that obtained if Freon is mixed

with the hydrogen even as low as one part in a thousand. The lower explosive limit of hydrogen in air is about four percent.

Since the response to hydrogen alone is limited to explosive mixtures, it is not safe to search for leaks without adding Freon. A mixture of ten-percent hydrogen will usually burn inside the detector unit and may flash back and ignite the hydrogen source. A 20-percent mixture usually flashes back and ignites the hydrogen source. The combustion of any mixture over four-percent hydrogen in the hot element will cause overheating and possibly cause damage to the element.

SAFETY PRECAUTIONS

It has been shown previously that the Type H leak detector is not safe to use in explosive atmospheres. In fact, the instrument is just a little safer than a candle flame for testing. To avoid a possible explosion of the gas, *the following precautions must be observed:*

1. NEVER ENTER OR TEST WHERE THERE IS AN EXPLOSIVE MIXTURE OF HYDROGEN. THE PRIMARY METHOD OF AVOIDING EXPLOSIVE MIXTURES IS TO TEST THE AREA WITH AN EXPLOSION METER. Such an instrument is available from Mine Safety Appliances Co., Davis Emergency Equipment Co., Inc., and others.

2. NEVER TEST FOR LEAKS WITHOUT FIRST ADDING FREON AND ALLOWING TIME (MIX) FOR MIXING.

3. AVOID TESTING IN AREAS WHERE THE INSTRUMENT GOES OFF SCALE ON THE LOW-SENSITIVITY SCALE.

4. NEVER TEST IN VENTS TO ENCLOSED SPACES SUCH AS BEARING HOUSINGS, OIL TANK VENTS, OPEN PIPES, ETC., WITHOUT FIRST TESTING WITH THE EXPLOSION METER.

EFFECTS OF HYDROGEN EXPLOSION

The explosion of several cubic feet of hydrogen and air mixture will cause relatively little damage. It will, in most cases, singe the hair on forearms, etc., but will not cause burns. A larger

volume of mixture in an enclosed space, such as under a generator, would probably cause flash burns and would be more apt to cause a fire. The ignition of an explosive mixture in a large confined space such as an oil tank might have disastrous results.

Refer to *Instructions GEI-32986* for information regarding leak detection in hydrogen-cooled generators.

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